Leakage resistance of a self-etch sealer-cone obturation system

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Introduction

Leakage is often a hidden factor in endodontic failure. It is recognised that virtually all endodontic restorations leak to some degree, although a recent study has demonstrated that the amount of detectable leakage varies with the penetrant.1 Unfortunately, when teeth are treated endodontically, the ability to sense bacterial breakdown is lost; consequently, the patient can no longer detect a need to seek dental care. In fact, percolation at the restoration’s margins may be long standing before the dentist becomes aware of it.2 As a result, damage can occur before adequate dental care is sought; therefore, the leakage behaviour of endodontic restorations is a matter of concern to both the treating dentist and the patient.

The use of adhesive obturation materials is known to significantly slow or stop coronal-apical bacterial migration3 but significant dye and bacterial leakage may occur within two days following exposure of obturated root canals to artificial and natural saliva.4 This can lead to complete bacterial leakage.4 Other studies confirm that dye leakage can occur in as few as three days.5

Gutta percha and various sealers have traditionally been used for endodontic obturation. This despite gutta percha not offering an effective barrier to crown-down leakage when exposed to the oral environment because of its inability to bond to various sealers.6

Recently, resistance to leakage has been improved through application of adhesive dentistry technology to endodontic obturation. The present study compares the leakage behaviour of the Resilon-Epiphany self-etch adhesive (R-SERS) and Resilon-Epiphany Resin Primer Sealer (R-RPS) obturation systems with that of gutta percha with both AH26 and zinc oxide eugenol (ZOE) sealants using an electrochemical methodology (Figs. 1a & b).7–9 This approach was adopted because of its accuracy, convenience and high correlation with traditional dye leakage studies.10

Methods and materials

Ten human single-rooted teeth with 20 mm average working length were used in this leakage study. Coronal access was prepared in each tooth and patency confirmed with a hand file. The canals were then instrumented to apical size ISO #40 with a .06 taper and irrigated with a 5% NaOCl solution. The canals were dried with paper points, rinsed with 17% EDTA, and then re-dried with paper points. A Resilon cone (Pentron) corresponding to the final canal size of ISO #40 with a .06 taper was placed into each specimen tooth, and a radiograph was taken to verify fit of the cone. Epiphany self-etch sealer (Pentron) was placed onto the fitted cone, and the cone was inserted to

Table I. Mean leakage currents (and their standard deviations and coefficients of variation) at 30 days.

<table>
<thead>
<tr>
<th></th>
<th>GP-AH26</th>
<th>R-RPS</th>
<th>GP-ZOE</th>
<th>R-SERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>404.6</td>
<td>6.9</td>
<td>271.3</td>
<td>53.7</td>
</tr>
<tr>
<td>S.Dev</td>
<td>313.7</td>
<td>8.9</td>
<td>204.5</td>
<td>27.6</td>
</tr>
<tr>
<td>CofV in %</td>
<td>77.5</td>
<td>129.1</td>
<td>75.4</td>
<td>51.5</td>
</tr>
</tbody>
</table>
working length into each tooth. Excess coronal Resilon cone was removed to the level of the canal orifice using a Touch 'n Heat (SybronEndo). Specimens were then allowed to self-cure for 30 minutes before being placed into a container with a 100% humidity atmosphere.

After endodontic obturation, a Class I preparation was placed in the occlusal surface of the teeth and a PVC-covered copper wire was inserted and placed in contact with the endodontic sealer cone and sealed in place using sticky wax. Thereafter, all external surfaces were coated with three layers of nail varnish to seal them and prevent leakage. The apices of all teeth were left uncoated and patent.

The teeth were immersed up to the CE junction in 0.9% NaCl solution, with a stainless steel counter electrode that was placed in the specimen container. A 20V DC voltage was connected between the stainless steel and each tooth in turn, and current flow was determined in accordance with Ohm’s Law by voltage drop across a standard resistor (100Ω) in the circuit (Fig. 2).

The leakage behaviour of the test specimens (R-SES) was compared with the behaviour of teeth obturated with gutta percha and ZOE (GP-ZOE) sealer, gutta percha and AH26 (GP-AH26) sealer, as well as teeth obturated with the Resilon-Epiphany Resin Primer Sealer (R-RPS) system in a previous study. Current flow in the circuit was observed for 30 days. At 30 days, one-way ANOVA and Scheffé’s Method were used to compare and identify any statistically significant differences in the leakage behaviour at an a priori “α=0.05.

Results

The leakage behaviour of the four groups of specimens over the test period is shown in Figure 3, while the 30-day data are summarised in Table I and Figure 4. It was found that the teeth obturated with the Resilon-Epiphany self-etch system (R-SES) showed a slow but progressive leakage with time, while the R-RPS obturated teeth exhibited minimal leakage until
research on leakage resistance

In contrast, the GP-AH26 and GP-ZOE obturated teeth showed a continuous and relatively rapid increase in leakage current until 20 to 25 days when the current appeared to plateau until the end of the study.

All four groups of specimens showed the customary scatter found in endodontic leakage studies, as shown by the coefficients of variation and the current ranges. However, the variability within both the R-SES and the R-RPS obturated teeth was markedly lower than for the GP with sealer-obturated teeth.

Statistical analysis indicated that the leakage of the GP-AH26 specimens was significantly greater (p<0.001) than that of the R-RPS and R-SES groups of specimens. There were no differences (p>0.05) between the leakage currents found for R-RPS and R-SES obturated teeth. The variability within the GP-ZOE group was such that no statistically significant differences (p>0.05) were found between it and the R-RPS, R-SES and GP-ZOE groups.

Discussion

It is generally believed that all endodontically treated teeth undergo leakage, and this view is supported by the literature. Ideally, all obturated teeth should show zero leakage, but this is a situation does not exist even for cavity restorations, which poses the question of how much leakage is acceptable.

While the ideal may never be attainable, the data presented here indicate that while teeth obturated with Resilon with resin sealer (R-SERS and R-RPS) do exhibit leakage, the observed leakage is almost of an order of magnitude less than that found with conventional obturation materials. Further, the variability within the data appears to be much lower.

While the technique and the obturation system both affect the restoration leakage behaviour, recent work suggests that resin obturation systems may exhibit superior resistance to endodontic leakage. The present study, which evaluated a self-etch adhesive and cone system, indicates that rapid progress is being made in reducing leakage to minimal levels and that the reported self-etch methodology with its inherent convenience and speed is a significant advance in endodontic therapy.

An interesting finding, and one that has been observed in other studies, is the onset or increase in leakage at approximately 20 days for obturated teeth that show initially very low leakage behaviour. This behaviour at three weeks is paralleled by the plateau that occurs with obturated teeth exhibiting high initial leakage rates. The reason for this behaviour is unclear; possibly, it is an inherent aspect of endodontic leakage behaviour.

Conclusion

The leakage of endodontic restorations has long been recognised but only in recent years has it been considered a serious cause of endodontic failure. In particular, marginal breakdown over time will lead to leakage with its consequent failure through apical bacterial migration. The findings presented here suggest that the new technology of self-etch adhesive obturation materials can slow this leakage, representing a significant advance in endodontic therapy.